7.1 Why we use Machines

I. Machines - a device that makes work easier
- A. Complex Machines vs Simple Machines
  - 1. Simple Machines do work through one movement
  - 2. There are six types of simple machines
    - → Figure 7-1, p.180

II Advantages of Simple Machines
- A. Machines make work easier by changing force you exert in size, direction, or both
- B. Overcoming gravity and friction
  - 1. When using a simple machine, you are trying to move something that resits being moved
- C. Applying Force and Doing Work
  - 1. Two forces are involved when a machine is used to do work
    - (Fe) ← a. Force applied to the machine = effort force
    - (Fr) ← b. Force applied by machine to overcome resistance = resistance force

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2. Must consider two kinds of work, work done on the machine and work done by the machine
   - a. Work done on the machine = Work input (W_{in})
   - b. Work done by the machine = Work output (W_{out})
   - c. Equation: $W_{in} = F_e \times d_e$ (displacement of effort force)
     $W_{out} = F_r \times d_r$

3. Ideal Machines – no energy is converted (lost) to heat
   - a. Ideal Machine is where $W_{in} = W_{out}$ or $F_e \times d_e = F_r \times d_r$

D. Mechanical Advantage – # of times a machine multiplies the effort force
- 1. $MA = \frac{\text{resistance force}}{\text{effort force}} = \frac{F_r}{F_e}$
- 2. Some machines don't multiply force, they simply change the direction of the effort force

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Force applied over a distance

W = F·d

Bellringer

using energy

→ What is the difference between work & Power? energy per unit of time

→ What is efficiency?

→ What is mechanical advantage? What does it measure?

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Bellringer

→ What are the 6 simple machines?
inclined plane, pulley, wheel-axle, lever, wedge, screw

→ What are the 3 ways machines make work easier?
change size, direction, or the distance of a force

→ A pulley uses a 250 N force to lift a 2,750 N crate. What is the MA of the pulley?

$MA = \frac{F_{out}}{F_{in}}$ $\frac{2,750}{250} \rightarrow 11 = MA$

Oct 14-9:50 AM

work and power

Grade: 8th

Subject: phys sci

Date:

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1 Find the effort force needed to lift a 2000-N rock, using a jack with a mechanical advantage of 10. Remember, MA = (Fr/Fe). Units for answer is N.

$\frac{2000N}{X} = 10$

200

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2 A carpenter uses a claw hammer to pull a nail from a board. The nail has a resistance of 2500 N. The carpenter applies an effort force of 125 N. What is the mechanical advantage of the hammer?

$\frac{2500\ N}{125\ N} = 20\ MA$

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3 The force applied to a machine is called the effort force.

True

False

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4 A simple machine does work with a few movements.

True
False

basically one

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5 Suppose you want to use a simple machine to lift a 6,000-N log from a fallen tree. What effort force will you need if your mechanical advantage is 25 (answer in N)?

$\frac{6000\ N}{x} = 25$

$\frac{6000}{25}$

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7.2 The Simple Machines

I. Levers - a point, free to pivot, or turn, about a fixed point

A. Fixed point = fulcrum

1. Part of lever where effort force is applied = effort arm
2. Part of lever that exerts resistance force = resistance arm

B. Finding the Ideal Mechanical Advantage

1. IMA = $\frac{\text{length of effort arm}}{\text{length of resistance arm}}$ = $\frac{Le}{Lr}$

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C. 3 types of levers

1. 1st class : fulcrum between Le + Lr, multiplies distance
2. 2nd class : Lr between fulcrum and Le, multiplies force
3. 3rd class : Le between fulcrum + Lr, MA is less than 1

II Levers with a human touch

A. Body's structural system contains 1st - 3rd class levers → Figure 7-6 for examples

III Pulling with Pulleys

A. Pulley - grooved wheel with a rope or chain running along the groove

1. Fixed pulley - attached to immovable object
   a. IMA = 1, does not multiply force
2. Movable pulley - attached to a crane, IMA =
   a. multiplies effort force
3. Block - Tackle - combination of movable + pul
   a. IMA = 4, see Figure 7-8 p.191

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IV Wheel and Axle - simple machine consisting of two wheels of different sizes that rotate together

A. Examples: door knob and faucet handle

1. IMA = $\frac{\text{radius of wheel}}{\text{radius of axle}} = \frac{rw}{ra}$

B. Gears are modified wheel-and-axle machines

V Inclined Plane - sloping surface used to raise objects

A. IMA = $\frac{\text{effort distance}}{\text{resistance distance}} = \frac{\text{length of slope}}{\text{height of slope}} = \frac{l}{h}$

VI The Screw

A. Inclined plane wrapped around in a spiral around a post

VII The Wedge - inclined plane with one or two sloping sides

A. Examples: chisels, knives, or blades

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Simple Machines Review

Grade: 8th

Subject: Physical Science

Date:

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1 A lever is a bar that is free to turn about a fixed point.

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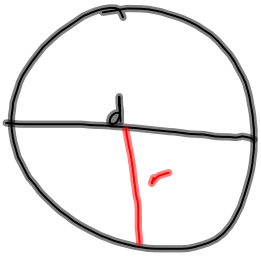
2 The fixed point of a lever is called the wheel-and-axle.

True
False

(fulcrum)

Dec 17-9:21 AM

3 An automobile steering wheel with a diameter of 48 cm is ued to turn the steering column with a radius of 4 cm. What is the IMA of this wheel and axle?



$IMA = \frac{r_{wheel}}{r_{axle}}$ $\frac{24}{4} = 6$

diameter =

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4 A ramp is an example of a simple machine called a(n) _____.

A screw
B lever
C inclined plane
D wheel and axle

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5 A sofa weighing 1200 N must be placed in a truck bed 1.0 m off the ground. A worker uses a force of 500 N to push the sofa up an inclined plane that has a slope length of 5.0 m. What is the efficiency of the inclined plane (a %)?

$W = f \cdot d$

$\frac{W_{out}}{W_{in}} \times 100\%$

$\frac{1200}{5(500)} \times 100$

$\frac{1200}{2500} \times 100 = 60\%$

Jan 1-1:52 PM

6 Chisels, knives, and axes are examples of _____.

wedges

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7.3 Mending with Machines: Technology

I. Human body as a Machine

A. Many parts of the human system work like machines

B. Bionics - the science of designing artificial replacements for parts of the human body

1. Artificial replacements = prostheses

C. Human muscles respond to small electrical shocks

1. FNS = Functional Neurotransmitter Stimulation

D. New technology is being developed to link computers to human organs + muscle fibers

Jan 1-1:40 PM

7.4 Using Machines

I. Compound Machines - a combination of two or more simple machines

A. Pedal Power

1. Pedal mechanism is a wheel-and-axle system made up of two wheels attached to the same axle

B. Finding the Mechanical Advantage (MA) of a Bicycle

1. Overall MA of a bicycle is the ratio of the resistance force exerted by a bik on road to effort force by rider on pedal

→ see Figure 7-16 (p. 199)

II Efficiency - measure of how much work put into machine is changed into useful work put out by machine

A. Efficiency = $\frac{W_{out}}{W_{in}} \times 100\% = \frac{F_r \times d_r}{F_e \times d_e} \times 100$

III Power - the rate at which work is done

A. Power = $\frac{work}{time}$ or $P = \frac{W}{t}$

1. Power is measured in Watts

Jan 2-10:34 AM

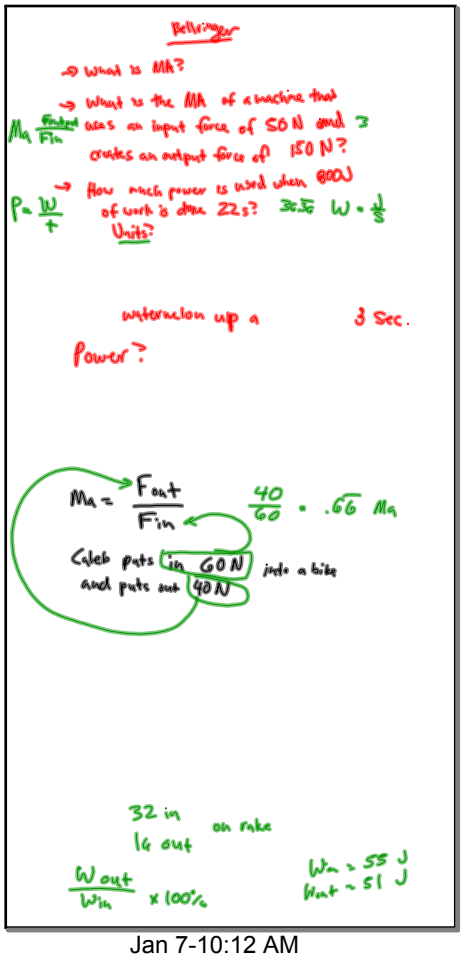
Work/Machines Review

Grade: 8th

Subject: Physical Science

Date:

Jan 1-1:40 PM



Jan 7-10:12 AM

Work/Machines Review

Grade: 8th

Subject: Physical Science

Date:

Jan 3-10:52 AM

1 A figure skater lifts his partner who weighs 600 N, 1.2 m in 2.4 s. How much power is required (answer in Watts (W))?

300 W

$\frac{600(1.2)}{2.4}$

Jan 1-1:54 PM

2 _____ is a measure of how much of the work put into a machine is changed to useful work put out by the machine.

Efficiency

Jan 1-1:45 PM

3 A power lifter lifts a set of weights that weigh 500 N a distance of 1.0 M in 1 second. How much power does the weightlifter exert (answer in Watts)?

500 W

Jan 1-1:47 PM

4 The are _____ types of simple machines.

A 3
B 6
C 8
D 9

Jan 6-6:30 PM

5 A(n) _____ is a combination of two or more simple machines.

A compound machine
B mechanical advantage
C ideal mechanical advantage

Jan 1-1:45 PM

6 Which of these cannot be done by a machine?

A multiply force
B multiply energy
C change direction of a force
D work

Jan 6-6:31 PM

7 In an ideal machine, the work input is _____ work output.

A is equal to
B is greater than
C is less than
D is independent of

Jan 6-6:32 PM

8 The _____ of a machine is the number of time it multiplies the effort force.

A efficiency
B power
C mechanical advantage
D resistance

Jan 6-6:33 PM

9 To raise a resistance 4 m, the effort rope of a single fixed pulley must move _____.

A 2 m
B 8 m
C 1 m
D 4 m

Jan 6-6:34 PM

10 The ideal mechanical advantage of a pulley system in which five ropes support an object is _____.

A 2.5
B 5
C 10
D 25

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11 In a wheel and axle, the resistance force is usually exerted by the _____.

A axle
B larger wheel
C gear ratio
D pedals

Jan 6-6:36 PM

12 The IMA of an inclined plane 8 m long and 2 m high is _____.

A 2
B 4
C 16
D 8

Jan 6-6:37 PM

13 As the efficiency of a machine increases, the _____ of the machine increases.

A work input
B work output
C friction
D IMA

Jan 6-6:37 PM

14 The IMA of an inclined plane can be increased by _____.

A increasing the length
B increasing the height
C decreasing the length
D making its surface smoother

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15 A cyclist applies a force of 250 N to the pedals of a bicycle. If the rear wheel applies a force of 200 N to the road surface, what is the MA of the bicycle?

0.8 MA

Jan 6-6:40 PM

16 Using a ramp 4 m long, workers apply an effort force of 1250 N to move a 2000-N crate onto a platform 2 m high. What is the efficiency of the ramp (in a %)?

80 %

$$E\% = \frac{W_{out}}{W_{in}} \times 100$$

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17 How much power does a person weighing 500 N need to climb a 3 m ladder in 5 s (answer in kilowatts, kW)?

0.3 kW

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18 A 500 N passenger is inside a 24,500 N elevator that rises 30 meters in one minute. How much power is needed for the elevator's trip (answer in watts, W)?

12,500 W

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19 A person uses a block and tackle to lift an automobile engine that weighs 1800 N. The person must exert a force of 300 N to lift the engine. How many ropes support the engine?

6

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